1. Factor the polynomial below completely, knowing that $x+3$ is a factor. Then, choose the intervals the zeros of the polynomial belong to, where $z_1 \leq z_2 \leq z_3 \leq z_4$. *To make the problem easier, all zeros are between -5 and 5.*

$$f(x) = 16x^4 + 16x^3 - 105x^2 - 9x + 54$$

A. $z_1 \in [-2.2, 0.1]$, $z_2 \in [-1.19, 0.23]$, $z_3 \in [0.4, 0.94]$, and $z_4 \in [2.36, 3.36]$

B. $z_1 \in [-3.3, -2.7]$, $z_2 \in [-2.54, -1.67]$, $z_3 \in [0.02, 0.66]$, and $z_4 \in [2.36, 3.36]$

C. $z_1 \in [-3.3, -2.7]$, $z_2 \in [-1.19, 0.23]$, $z_3 \in [0.4, 0.94]$, and $z_4 \in [1.68, 2.69]$

D. $z_1 \in [-3.3, -2.7]$, $z_2 \in [-1.63, -0.84]$, $z_3 \in [1.24, 1.45]$, and $z_4 \in [1.68, 2.69]$

E. $z_1 \in [-2.2, 0.1]$, $z_2 \in [-1.63, -0.84]$, $z_3 \in [1.24, 1.45]$, and $z_4 \in [2.36, 3.36]$

---

2. Perform the division below. Then, find the intervals that correspond to the quotient in the form $ax^2 + bx + c$ and remainder r.

$$\frac{15x^3 - 97x^2 + 168x - 77}{x - 4}$$

A. $a \in [57, 68]$, $b \in [-337, -332]$, $c \in [1515, 1519]$, and $r \in [-6142, -6136]$.

B. $a \in [13, 16]$, $b \in [-163, -155]$, $c \in [796, 797]$, and $r \in [-3269, -3257]$.

C. $a \in [13, 16]$, $b \in [-37, -35]$, $c \in [18, 23]$, and $r \in [3, 4]$.

D. $a \in [13, 16]$, $b \in [-53, -47]$, $c \in [10, 17]$, and $r \in [-45, -37]$.

E. $a \in [57, 68]$, $b \in [142, 144]$, $c \in [737, 743]$, and $r \in [2883, 2885]$.

---

3. Factor the polynomial below completely. Then, choose the intervals the zeros of the polynomial belong to, where $z_1 \leq z_2 \leq z_3$. *To make the problem easier, all zeros are between -5 and 5.*

$$f(x) = 25x^3 + 75x^2 + 56x + 12$$

A. $z_1 \in [-0.2, 0.2]$, $z_2 \in [0.9, 2.6]$, and $z_3 \in [2.78, 3.85]$

B. $z_1 \in [1.49, 1.78]$, $z_2 \in [0.9, 2.6]$, and $z_3 \in [2.36, 2.61]$

C. $z_1 \in [-2.59, -2.42]$, $z_2 \in [-3.5, -1.7]$, and $z_3 \in [-2.5, -1.58]$

D. $z_1 \in [0.33, 0.79]$, $z_2 \in [0, 1.3]$, and $z_3 \in [1.92, 2.46]$

E. $z_1 \in [-2.08, -1.76]$, $z_2 \in [-0.8, 0.1]$, and $z_3 \in [-0.43, -0.12]$

---

4. What are the *possible Integer* roots of the polynomial below?

$$f(x) = 6x^4 + 3x^3 + 2x^2 + 2x + 4$$

A. All combinations of: $\dfrac{\pm 1, \pm 2, \pm 4}{\pm 1, \pm 2, \pm 3, \pm 6}$

B. All combinations of: $\dfrac{\pm 1, \pm 2, \pm 3, \pm 6}{\pm 1, \pm 2, \pm 4}$

C. $\pm 1, \pm 2, \pm 3, \pm 6$

D. $\pm 1, \pm 2, \pm 4$

E. There is no formula or theorem that tells us all possible Integer roots.

---

5. Factor the polynomial below completely. Then, choose the intervals the zeros of the polynomial belong to, where $z_1 \leq z_2 \leq z_3$. *To make the problem easier, all zeros are between -5 and 5.*

$$f(x) = 15x^3 + 56x^2 - 105x - 50$$

A. $z_1 \in [-6, -4]$, $z_2 \in [-0.81, -0.19]$, and $z_3 \in [0.8, 1.8]$

B. $z_1 \in [-1.67, -0.67]$, $z_2 \in [0.19, 0.57]$, and $z_3 \in [4.9, 5.8]$

C. $z_1 \in [-6, -4]$, $z_2 \in [-2.86, -2.03]$, and $z_3 \in [-0.1, 1.3]$

D. $z_1 \in [-1.6, 1.4]$, $z_2 \in [2.21, 2.72]$, and $z_3 \in [4.9, 5.8]$

E. $z_1 \in [-6, -4]$, $z_2 \in [-0.06, 0.29]$, and $z_3 \in [4.9, 5.8]$

---

6. Perform the division below. Then, find the intervals that correspond to the quotient in the form $ax^2 + bx + c$ and remainder r.

$$\frac{4x^3 - 48x + 66}{x + 4}$$

A. $a \in [-20, -15], b \in [61, 73], c \in [-308, -302],$ and $r \in [1278, 1285]$.

B. $a \in [4, 7], b \in [16, 17], c \in [14, 22],$ and $r \in [129, 137]$.

C. $a \in [-20, -15], b \in [-68, -57], c \in [-308, -302],$ and $r \in [-1157, -1149]$.

D. $a \in [4, 7], b \in [-16, -10], c \in [14, 22],$ and $r \in [2, 5]$.

E. $a \in [4, 7], b \in [-27, -17], c \in [50, 55],$ and $r \in [-197, -190]$.

---

7. Factor the polynomial below completely, knowing that $x + 2$ is a factor. Then, choose the intervals the zeros of the polynomial belong to, where $z_1 \leq z_2 \leq z_3 \leq z_4$. *To make the problem easier, all zeros are between -5 and 5.*

$$f(x) = 12x^4 - 43x^3 - 21x^2 + 166x - 120$$

A. $z_1 \in [-3.47, -2.46], z_2 \in [-1.71, -1], z_3 \in [-1.56, -1.13],$ and $z_4 \in [1.5, 2.6]$

B. $z_1 \in [-2.22, -1.47], z_2 \in [0.11, 1.16], z_3 \in [0.44, 1.05],$ and $z_4 \in [2.7, 3.2]$

C. $z_1 \in [-4.53, -3.35], z_2 \in [-3.93, -2.74], z_3 \in [-0.56, -0.3],$ and $z_4 \in [1.5, 2.6]$

D. $z_1 \in [-3.47, -2.46], z_2 \in [-1.16, -0.7], z_3 \in [-0.93, -0.52],$ and $z_4 \in [1.5, 2.6]$

E. $z_1 \in [-2.22, -1.47], z_2 \in [1.05, 1.59], z_3 \in [1.32, 1.66],$ and $z_4 \in [2.7, 3.2]$

---

8. What are the *possible Rational* roots of the polynomial below?

$$f(x) = 4x^3 + 3x^2 + 7x + 6$$

A. $\pm 1, \pm 2, \pm 4$

B. All combinations of: $\dfrac{\pm 1, \pm 2, \pm 4}{\pm 1, \pm 2, \pm 3, \pm 6}$

C. $\pm 1, \pm 2, \pm 3, \pm 6$

D. All combinations of: $\dfrac{\pm 1, \pm 2, \pm 3, \pm 6}{\pm 1, \pm 2, \pm 4}$

E. There is no formula or theorem that tells us all possible Rational roots.

---

9. Perform the division below. Then, find the intervals that correspond to the quotient in the form $ax^2 + bx + c$ and remainder r.

$$\frac{6x^3 + 4x^2 - 34x + 28}{x + 3}$$

A. $a \in [-20, -9], \ b \in [56, 65], \ c \in [-213, -206], \text{ and } r \in [649, 653].$

B. $a \in [6, 10], \ b \in [-20, -19], \ c \in [43, 47], \text{ and } r \in [-158, -148].$

C. $a \in [6, 10], \ b \in [-17, -8], \ c \in [2, 9], \text{ and } r \in [-1, 6].$

D. $a \in [6, 10], \ b \in [18, 26], \ c \in [32, 36], \text{ and } r \in [119, 127].$

E. $a \in [-20, -9], \ b \in [-51, -46], \ c \in [-186, -177], \text{ and } r \in [-526, -517].$

---

10. Perform the division below. Then, find the intervals that correspond to the quotient in the form $ax^2 + bx + c$ and remainder r.

$$\frac{20x^3 + 63x^2 - 24}{x + 3}$$

A. $a \in [-67, -57], b \in [239, 245], c \in [-730, -721], \text{ and } r \in [2163, 2165].$

B. $a \in [20, 26], b \in [3, 7], c \in [-10, -7], \text{ and } r \in [0, 11].$

C. $a \in [20, 26], b \in [-17, -14], c \in [62, 70], \text{ and } r \in [-303, -294].$

D. $a \in [-67, -57], b \in [-119, -114], c \in [-354, -349], \text{ and } r \in [-1085, -1073].$

E. $a \in [20, 26], b \in [119, 127], c \in [364, 371], \text{ and } r \in [1080, 1086].$
